→ THERMOCHEMISTRY — A branch of chem in which we study heat change during a chemical reaction

① System — any thing under study in universe (for argument) Date: / /

e.g Glass of water. , glass → system

Surrounding — every thing outside the system

OHO 'bond form → exo
CC bond break → endo
end surrounding

① Open system → matter and energy → is exchangeable b/w system
② Closed system → Only energy or heat is exchangeable (mass — X)
③ Isolated system → Nothing is exchangeable

Y → D·PENDS

STATE FUNCTION:- condition of system e.g (T, P, V), enthalpy, ΔS, ΔE, ΔH

•) macroscopic property (measureable) → depends upon initial & final state.
→ not on the change adopted by a system
→ cannot be calculated by pathway

e.g $T_1 = 25°C$ $T_2 = 50°C$ $\Delta T = T_2 - T_1 = 50 - 25 = 25°C$

ΔT ↓ state function

→ Not state function: heat (Q), (W) work (they are not the property of system, values are developed during any process, doesnot belong to the system)

(W) ↓ initially work not exists.

Internal Energy:- (ΔE) (impossible to measure accurately) → E

(monoatomic) → sum of K.E (vib, trans, rot) + P.E (intermolecular forces & intra M.F)

e.g In noble gas like He gas, ΔE is only due to K.E (trans)

diatomic, Cl_2, trans + vib (bonds)

poly or triatomic BF_3, CH_4, NH_3 (molecule can also move) K.E → trans + vib + rotate

1st Law of Thermodynamics:- law of conservation of energy

→ $q = V + \Delta V$ · matter be created nor destroyed. V = form of energy

→ $\Delta E = V_2 - V_1$ (final) (initial)

$W = F \times S$

$W = PV = P\Delta V$

$\Delta E = q + w$

$\Delta E = E_2 - E_1$

K.E ∝ T.

+Q absorbed / -Q emit

+W by system / +W on the system

+U ∝ ↑T / -U ∝ T↓

MCQ NH_3 is enclosed in a container its total K.E energy comprises on

trans, vib, rot

Yousaf

Scanned with CamScanner

MCQs imp

→ Plants and animals are an example of
Day:) Open system (when a person loses wieght that energy is converted to energy) Date: (intake of food ⇒ output

→ The chemical systems are →) closed system (eg reaction in test tube
→ energy & mass cannot be exchangeable →) isolated system.
→ which of the following is not a state function
✓ ΔT , ✓ ΔH ✗ (q) Both A & B
produced during system, not the property of system.

✓ Which of the following is state function

→ All of the following are correct properties of state function? except
) It depends upon the intermediate of the reaction

→ Q ≠ W + ΔU ΔE = q + w
Q = W ≠ ΔU = 10 + (-20) = -10J
10J - 20 = -10J = ΔU
evolve

Chemical → change in energy
energetic

→ ΔE = q + W → by the system
= -10J - 20J = -30J

→ Which of the following is correct 1st law of thermodynamics
ΔE = E₂ - E₁ ΔE = q + PΔV
ΔE = q + W ✓ ΔU

→ if W = 0, then ΔE = ?
ΔE = q_v

(Boundary → a real or imaginary line which seperates system from surrounding)

→ most of the thermodynamic parameters are
system surrounding Phase ✓ state function (depends upon ~~path of state~~)
→ Boundary is the part of → surrounding

→ Anything under study → system.
→ Unit of energy J (SI) (system)
→ Total energy of system = K.E + P.E
→ All kind of forces are present in a system → comprise P.E

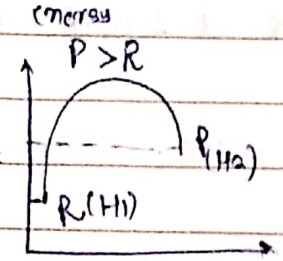
Yousaf

Scanned with CamScanner

Enthalpy → experimental method (ΔH_n or ΔH_s Class calorimetre ΔH_{sol})
→ Bomb calorimeter ΔH_c food fuels etc.
→ theoretical methods → Hess' law (indirect reactions) more than one step
Born Haber Cycle.

Day: Date:

formation
ΔH_f, $\Delta H_{lattice\ energy}$

	Endothermic	**Exothermic**
Heat	energy absorbtion	energy is evolved
ΔH (enthalpy change)	+ve	-ve kJ/mol → Unit of ΔH
Heat transfer	surrounding → system	system → surrounding
Temp	increase due to absorbtion Surr → T ↓ system ↑	decrease due to emition e.g combustion.
Stability	Reactents → more stable than P	Product → more stable due to release of energy
Examples	• Carbon + Oxygen → CO_2 ($\Delta H = -393.7$ kJ/mol) • $N_2 + 3H_2 \rightarrow 2NH_3$ ↓ $\Delta H = -46.23$ kJ/mol.	$N + O \rightarrow 2NO$ $\Delta H = +3$ (inert) $H_2O_{(l)} \xrightarrow{endo} H_2O_{(g)}$ (vapours)
Graph		$\Delta H = H_2 - H_1$ = (-ve)
	$\Delta H = H_2 - H_1$ 100 - 50 = (+ve)	→ spontaneous reaction which more from high to low

- Evaporation → endo
- Combustion → exo
- Respiration → exo
- Photosynthesis → endo. (sunlight absorb) ~~exo~~
- Neutralization → exo
- Sublimation → endo $S \rightarrow G$
- B.P & M.P → endo
- Freezing → exo

Spontaneous
→ on its own
→ unstable reactents
→ when a spark is needed, and then reaction continues
→ combustion.
→ NaOH + HCl → H_2O + NaCl.

Non-spontaneous
→ continuous supply of energy require
→ evaporation
→ high to low flow of water.
→ burning of candle ↓ O_2

Scanned with CamScanner

Enthalpy → heat content

Day: $C_{(s)} + OH_{2(l)} \xrightarrow{\Delta} CO_{(g)} + H_{2(g)}$ $\Delta H = +118\ kJ/mol$. Date: / /

Standard conditions (•)
T = 25°C P = 1 atm 1M solution
→ T → 298 K
→ P → 101325 N/m²

→ Standard change in enthalpy $R \xrightarrow{STP} P$ $-\Delta H$ OR $+\Delta H$
$H = E + pV$ amount of heat released or absorbed during reaction under standard condition
→ change in energy at constant pressure ,T

(1) ~~ΔH°_f~~

MCQ's: (1) Which of the enthalpy is exothermic in nature.
(2) ✓ Enthalpy of reaction
(3) ✓ atomization
(1) ✓ neutralization
All of the above

(2) Which of the following enthalpy may be exothermic or endothermic
(3) Enthalpy which is always positive

→ The standard heat of formation is measured at 1 atm. and 25°C
→ The standard temperature is used to measure the volume of gas
• 0°C = 273 K
→ The heat of vaporization of water = 44.0 kJ/mol.
• $H_{2(g)} + 1/2\ O_{(g)} \rightarrow H_2O$
ΔH of above reaction → enthalpy of formation
→ WOF ΔH is measured when solution is infinite dilute.
• Enthalpy of solution
→ ΔH which is always endothermic in nature
• Enthalpy of atomization.
→ Enthalpy of neutralization of all the strong acid and base has the same value bcz
• The net chemical change involves the combination of H^+ or OH^- ion to form water

ΔH_{sol} = exo or endo

Yousaf

Scanned with CamScanner

→ If work done in a gaseous system is equal to zero then its ΔH is approximately equal to q_v W=0 W.PΔV

Day: Date: / /

→ The enthalpies of all elements in their standard states = zero
compound ≠ zero

→ The enthalpy of atomization is +ve

→ The enthalpy of neutralization -ve

$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(s)}$

$\Delta H = \Delta E + P\Delta V$

$P\Delta V = nRT$

$\Delta H = \Delta E \quad \Delta H - \Delta E = \Delta nRT$

$\Delta n = n_p - n_r$ (moles)

$= 1 - 2 = -1$

$\Delta H - \Delta E = -RT$

→

HESS'S LAW (CCl4, B2O3, CO)

A $\xrightarrow{\Delta H}$ B

initial → final

ΔH1 ↓ or ↗ ΔH3

C → D

ΔH2

graphite

$C + O_2 \xrightarrow{\Delta H} CO_2 \quad \Delta H = -393.7\ kJ/mol$

→ $C + \frac{1}{2}O_2 \rightarrow CO\ (\Delta H_1) \quad \Delta H_1 = ?$

→ $CO + \frac{1}{2}O_2 \rightarrow CO_2\ (\Delta H_2) \quad \Delta H = -283\ kJ/mol.$

$\Delta H = \Delta H_2 + \Delta H_1$

$\Delta H - \Delta H_2 = \Delta H_1$

$\Delta H_1 - 393.7 + 283 = -110.7\ kJ/mol$

→ WOF shows enthalpy of atomization

$NA(s) \rightarrow NA(g)$

→ enthalpy of neutralization

$HCl + NaOH \rightarrow H_2O + NaCl_{(aq)}$

→ formation as well as combustion

$C_{(s)} + O_{2(g)} \rightarrow CO_2$

→ formation but not combustion

$Ca_{(s)} + \frac{1}{2}O_2 \rightarrow CaO.$

mul. ×2

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O \quad \Delta H = -285.8$

→ $H_2O_{(s)} \rightarrow H_2O_{(l)}$

Acc to Hess's law

$\Delta H = \Delta H_1 + \Delta H_2$

$-285.8 + 44 = \Delta H_2$

$-241.8\ kJ/mol = \Delta H_2$

→ Which of the following has highest amount of lattice.

→ NaF

LE ∝ charge / size

Increasing order

→ minimum energy NaI

I > Br > Cl > F

Yousaf

Scanned with CamScanner

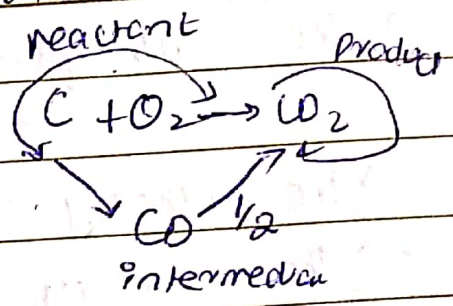
→ All are properties of spontaneous reactions except
• natural • irreversible, unidirectional • ✓reversible

Day: ~~reaction can be~~ • forward reaction → spontaneous Date: / /
reverse reaction → non-spontaneous

→ $C + O_2 \rightarrow CO_2 + 393.7\ kJ/mol$ exothermic

— $CO + \frac{1}{2}O_2 \rightarrow CO_2 \quad \Delta H_2 = -283\ kJ/mol$

$C + \frac{1}{2}O_2 \rightarrow CO \quad \Delta H_1 = ?$



$\Delta H = H_1 + H_2$

$\Delta H - H_2 = -393.7 - (-283\ kJ/mol = -110.7\ kJ/mol.$

→ Value of cyclic process is always +ve = zero.

→ The elements which are not completely oxidized are used in Hess's law.

Q. Enthalpy of which of the following can be measured by Hess's law.

Al_2O_3 ~~BF_3~~ B_2O_3 CCl_4 ✓All

Scanned with CamScanner